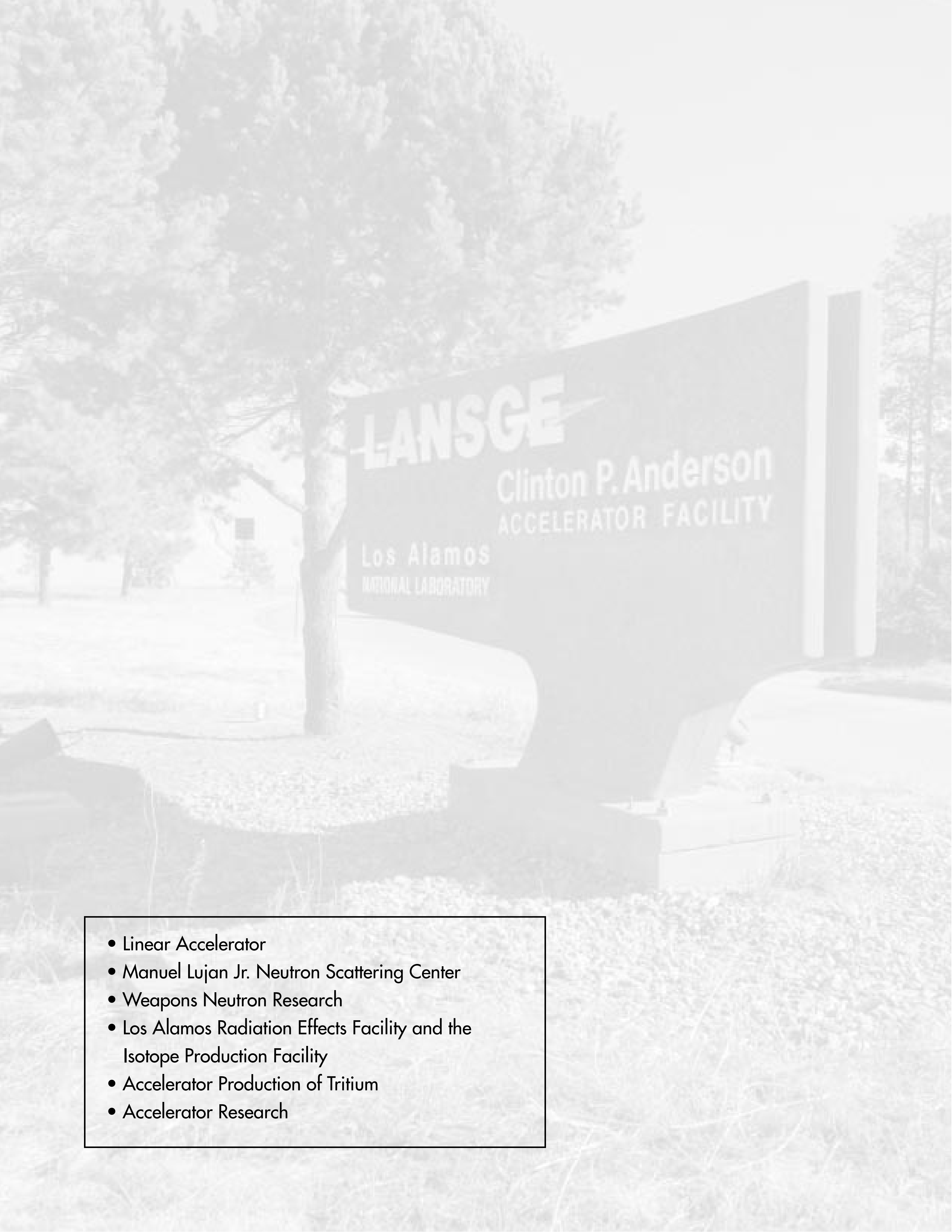
OVERVIEW OF THE LANSCE FACILITY



- Linear Accelerator
- Manuel Lujan Jr. Neutron Scattering Center
- Weapons Neutron Research
- Los Alamos Radiation Effects Facility and the Isotope Production Facility
- Accelerator Production of Tritium
- Accelerator Research

OVERVIEW OF THE LANSCE FACILITY

Los Alamos Neutron Science Center (LANSCE) consists of a proton linear accelerator, the Manuel Lujan Jr. Neutron Scattering Center, the Weapons Neutron Research facility, and several other experimental areas. Pulsed spallation neutrons are produced for neutron research and applications.

LANSCE is one of the largest nuclear science facilities in the world and is available for use by qualified members of the world's scientific community. The LANSCE mission is to become the United States' center for the development and use of spallation neutron sources.

LINEAR ACCELERATOR

The proton linear accelerator (linac) at LANSCE is a half mile long and provides 1-milliampere pulses of 800-million-electron-volt protons at a repetition rate of 120 per second. From the LANSCE linac, beams are guided to targets at the Manuel Lujan Jr. Neutron Scattering Center, the Weapons Neutron Research facility, and Experimental Areas A, B, and C.

Beginning of the accelerator at the 201 beam line.

MANUEL LUJAN JR. NEUTRON SCATTERING CENTER

The LANSCE linear accelerator delivers a proton beam to the tungsten target at the Manuel Lujan Jr. Neutron Scattering Center. When the protons hit the tungsten target, a spallation reaction occurs, producing neutrons with a wide range of energies.

The Manuel Lujan Jr. Neutron Scattering Center is an international user facility where scientists from industry, academia, and other national laboratories perform neutron scattering experiments. Research projects are conducted in

- materials science
- condensed-matter physics
- polymer physics
- chemistry
- biology
- fields of concern for national security

WEAPONS NEUTRON RESEARCH

The Weapons Neutron Research (WNR) facility has two experimental target areas: Target 2 and Target 4. Target 2 can exploit the variable-energy feature of the linac and is used to study proton-induced reactions. When the protons from the linac hit Target 4, an intense beam of neutrons with a continuous spectrum up to 600 million electron volts is produced. Target 4 is the most intense, high-energy neutron source in the world.

At the WNR facility, research is conducted in

- basic nuclear physics
- radiation-enhanced superconductivity
- defense applications
- energy production
- applied nuclear technology

LOS ALAMOS SPALLATION RADIATION EFFECTS FACILITY AND THE ISOTOPE PRODUCTION FACILITY

The Los Alamos Spallation Radiation Effects Facility (LASREF) is located immediately before the main accelerator beam stop. The primary 800 MeV proton beam of up to 1.0 milliampere current is available for a variety of applications, making this the highest intensity high-energy proton facility in the world. Research at the beam stop includes materials damage studies and the testing of components for future spallation target applications.

Currently, radioisotopes are also produced at the beam stop, but a new radioisotope production facility is planned. The new facility will not use the beam stop but rather, will have its own beam line that veers off from the main linac. Radioisotopes are widely used in medical and industrial applications and research.

ACCELERATOR PRODUCTION OF TRITIUM

At TA-53, a low-energy accelerator is being constructed as a prototype for the front end of a 100-milliampere proton accelerator. The full accelerator, incorporating the front end being demonstrated at TA-53, may be constructed at the Department of Energy's Savannah River site in South Carolina, for the Accelerator Production of Tritium (APT) Project.

The low-energy demonstration accelerator at TA-53 will have an average beam current nearly 100 times greater than any operating accelerator. However, because of its low output beam energy, it will produce very few neutrons or gamma rays, and all radiation will be contained within the well-shielded beam tunnel.

Successful beam operation on TA-53's low-energy demonstration accelerator will open the door to designs for a new class of accelerators, important for the clean and efficient production of neutrons. These accelerator-based neutron sources can in turn be used for basic research, production of tritium, and transmutation (elimination) of radioactive waste.

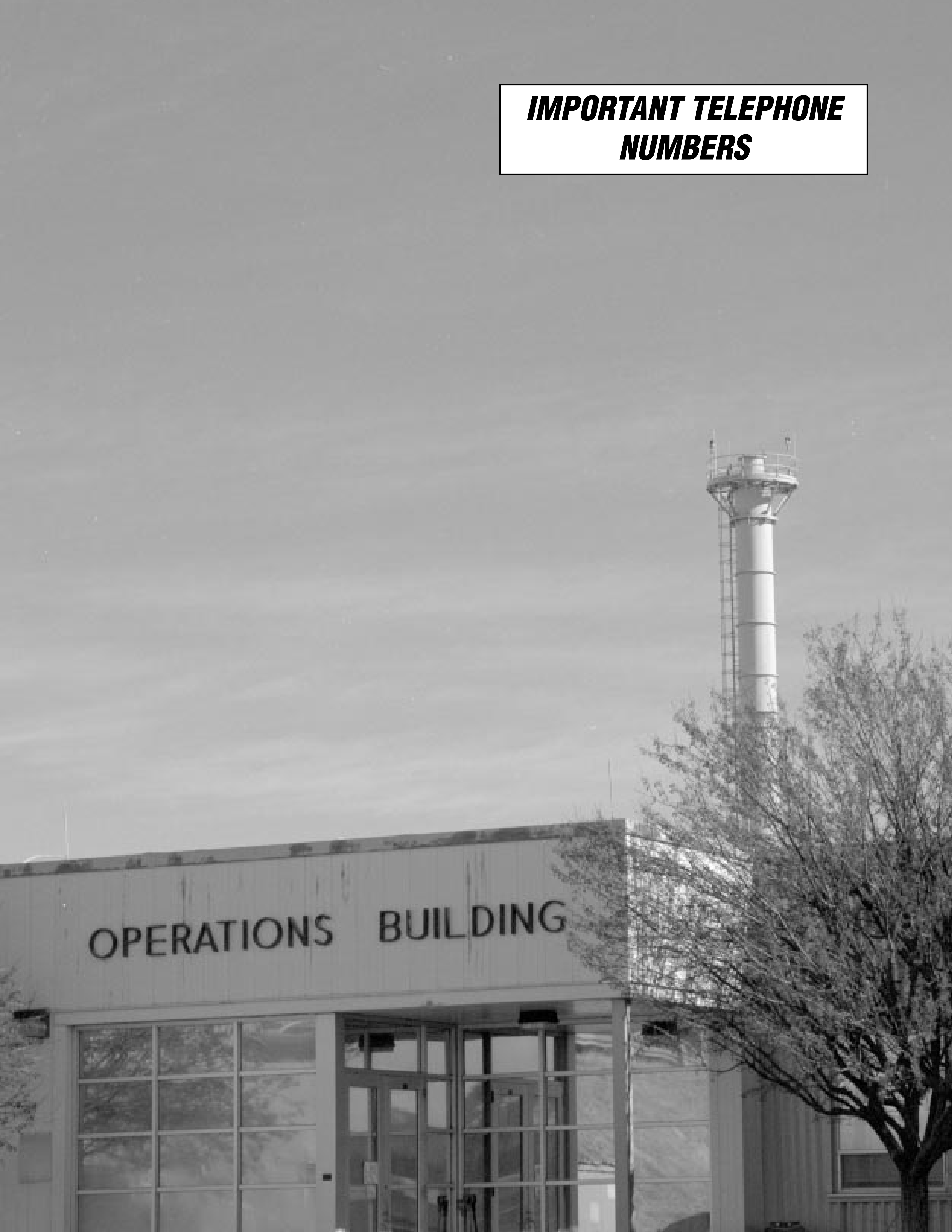
ACCELERATOR RESEARCH

In addition to construction of the low-energy demonstration accelerator, other projects at TA-53 focus on the development of new and innovative particle accelerator designs and the application of such designs to programs in national defense, energy, medicine, and industry.

Research areas include

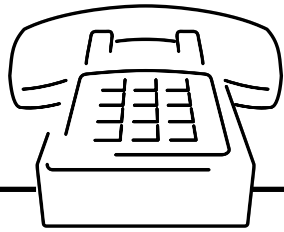
- beam dynamics
- transport systems
- accelerating structures
- radio-frequency systems
- high-power microwave effects

IMPORTANT TELEPHONE NUMBERS



- Who's Who at TA-53
- Laboratory-Wide Assistance

IMPORTANT TELEPHONE NUMBERS



WHO'S WHO AT TA-53

Facility Manager
Telephone: 5-2584

The facility manager is responsible for ensuring that all operations at TA-53 are conducted within the defined and approved safety envelope, and for providing facility services to meet the goals of resident programs.

Environment, Safety, and Health Team Leader
Telephone: 5-4666

The environment, safety, and health (ES&H) team leader oversees day-to-day implementation of environment, safety, and health policies and procedures at TA-53. The ES&H team leader can provide guidance and can refer you to ES&H resources at the facility if needed.

Building Managers
Telephone: 5-2584

Building managers oversee the day-to-day operations of each building at TA-53. Contact the facility management office (5-2584) for names and telephone numbers of building managers.

Radiological Control Technicians
Telephone: 7-7069

Radiological control technicians (RCTs) provide guidance and address questions and concerns about radiation. An RCT can let you know the latest radiological conditions in an area and may be called to monitor an area prior to beginning work or after work has been completed.

Waste Management Coordinators

Telephone: 7-6995 or 5-8544

The waste management coordinators are the primary contacts for coordinating waste disposal activities and waste minimization and should be contacted in the case of a spill. Questions regarding waste disposal or the generation of waste should be addressed to one of the waste management coordinators.

Industrial Hygienist

Telephone: 5-1869

An on-site industrial hygienist is available to evaluate workplace hazards, including potential exposure to chemicals, ergonomic problems, and noise.

Safety Engineer

Telephone: 7-6624

The safety engineer can evaluate and provide guidance on the control of industrial hazards associated with cranes and forklifts, pressure vessels, and construction activities.

LABORATORY-WIDE ASSISTANCE

Emergency Management and Response

Telephone: 7-6211

Emergency Management and Response (EM&R) oversees the Laboratory's preparation for emergencies and coordinates emergency response. The EM&R Incident Commander provides direction at the scene of an accident or emergency.

Protective Force

Telephone: 7-4437

Protection Technology Los Alamos (PTLA) provides armed and unarmed security police for the protection of workers, government information, and property at the Laboratory.

General Emergencies

Telephone: 911

SITE ACCESS

The objectives of this section are that you understand

- TA-53 entrance procedures
- requirements for access during nonwork hours
- how to obtain authorization for visitors to enter

SITE ACCESS

The gate and gate attendant at the entrance of TA-53 are in place to ensure that only Los Alamos National Laboratory (LANL) employees, contractors, and visitors with official business have access to the facility.

ENTRANCE PROCEDURE FOR LANL EMPLOYEES AND CONTRACTORS

- Slowly approach the gate.
- Show the attendant your LANL identification badge.
- Follow the gate attendant's directions.

If you forget your badge, come to a complete stop on the far right-hand side of the gate. The gate attendant will need to get authorization before allowing you to enter the facility.

ACCESS DURING NONWORK HOURS

Use the magnetic strip on the back of your LANL identification badge to open the gate after hours or on weekends.

After hours, access to some office buildings is controlled by badge readers. The outside doors are automatically unlocked at 7:00 a.m. and locked at 6:00 p.m. All employees and visitors are given access to the office buildings where they work. If you require access to other buildings after hours, you must get approval from one of the organizations that occupy the building.

VISITOR ACCESS AUTHORIZATION

Hosts should obtain access approval prior to a visitor's arrival by calling the gate attendant. If access is not authorized ahead of time, the gate attendant must call the host from the gate when a visitor arrives. If the gate attendant cannot get verbal approval from the host, the visitor will not be allowed access.

At the beginning of each visit, visitors must check in at the Visitor Center in Building MPF-1.

Any visitor without a badge who comes to the facility with you is your responsibility, and you must ensure that the visitor does not wander on site unescorted.

IF YOU...	THEN...
Forget your badge	Stop at the gate and sign in
Will be escorting a visitor	Accept full responsibility for the visitor
Need to work on the weekend	Use the badge reader at the gate for access

STUDY QUESTION

Only ________ are allowed to have access to TA-53.

a. badge holders
b. people who have received authorization
c. none of the above
d. both a & b

ANSWER

d

HAZARDOUS MATERIALS AND WASTE OPERATIONS

The objectives of this section are that you understand

- the responsibilities involved when you work with chemicals and hazardous materials
- the characteristics of hazardous waste
- the responsibilities involved when you perform operations that generate chemical or hazardous waste
- how to respond to a spill

HAZARDOUS MATERIALS AND WASTE OPERATIONS

The management of hazardous materials and hazardous wastes is a critical issue for the Laboratory. Hazardous materials may include chemicals, radioactive sources, metals, or other materials that could pose a hazard to workers or to the environment.

Our goal is to ensure the safety of workers when they are working with or around hazardous materials and to minimize the amount of waste disposed of or treated.

CHEMICAL SAFETY

Every chemical in use at the Laboratory must be properly labeled. In addition, the Laboratory requires that a current Material Safety Data Sheet (MSDS) be readily available for each chemical used at the facility. The MSDS includes, as appropriate, the following information: what the chemical is, the manufacturer, hazardous ingredients, physical data, fire and explosion risk, health hazard data, reactivity data, spill and leak procedures, special protection information, and special precautions.

Even consumer products that you would buy at a hardware store must have a label and an MSDS when you use them at the Laboratory. Many of the experimental areas at TA-53 have hazard communication stations where MSDSs are kept. If you do not have an MSDS or label for a chemical, you may be able to find many of the more common MSDSs on the World Wide Web.

If you need assistance in getting a label or an MSDS, contact the facility manager's office (5-2584) or the on-site industrial hygienist (5-1869).

RADIOACTIVE MATERIALS AND WASTE

The handling of low-level radioactive materials is fairly common for users performing experiments at LANSCE. Any potentially radioactive waste or radioactive material coming from a radiological area must be surveyed and tagged by a radiological control technician (RCT) before it is removed. If an item is found to be free of radioactivity, a release tag will be issued and should remain on the material while it is on site. In order to preserve knowledge of process of materials which are likely to be activated, special sticker-type labels are used. Do not remove these stickers unless an RCT has surveyed and released the material.

Experimental apparatus or samples which are activated must be stored in a radioactive material control cabinet or storage area between uses.

Contact an RCT if you need clarification of the required procedures that you must follow in a radiological area.

HAZARDOUS WASTE

Once a hazardous material is used in an operation, or a material is activated or exposed to radioactively contaminated material, any waste produced must be handled as hazardous, radioactive, or mixed waste. This means that you cannot throw these types of wastes in the regular trash containers and you cannot dump chemicals down a drain. Doing so could result in consequences ranging from fines to criminal and civil penalties to facility or operational shutdowns.

Besides waste, you cannot throw away outdated chemical products (items whose expiration dates have passed). These items must be disposed of in the same manner as waste.

A material that has been discarded as waste and exhibits any of the following characteristics must be considered hazardous waste:

Satellite Storage Area. A yellow book is used to keep track of the material stored.

- toxicity
- corrosiveness
- ignitability
- reactivity

The federal Resource Conservation and Recovery Act (RCRA) regulates hazardous waste from its generation to its disposal. The act specifies extensive and detailed requirements for the storage and handling of hazardous waste.

The TA-53 waste management coordinators (7-6995 or 5-8544) are the primary contacts for coordinating waste disposal and waste minimization. If you are unsure whether waste you have generated is hazardous, speak to a waste management coordinator. Please note that Laboratory employees and contractors who generate chemical or hazardous waste cannot prepare waste for disposal or storage unless they have completed the Laboratory's Waste Generator Training.

Until it is picked up for disposal, hazardous waste is stored in Satellite Storage Areas located in the immediate area of waste generating operations. When you place material in a Satellite Storage Area, you must ensure that it is properly contained and labeled. If there is not a Satellite Storage Area near where hazardous waste is generated, call a waste management coordinator to establish a new Satellite Storage Area.

Before you produce waste,

- know your operations and the products they produce
- know the rules of disposal
- plan ahead so as to avoid producing mixed waste when at all possible (hazardous waste containing radioactive material is classified as "mixed" waste and is more difficult and costly to handle)

SPILL RESPONSE

If there is a spill in your work area and the material spilled exceeds one gallon, is hazardous as defined by RCRA, or is unidentifiable,

- immediately call Emergency Management and Response (7-6211)
- then call a waste management coordinator (7-6995 or 5-8544) and your supervisor

They will assist you with spill containment and cleanup.

If the spill occurs in a controlled or radiological area,

- immediately call an RCT (7-7069)
- then call Emergency Management and Response, a waste management coordinator, and your supervisor

Evacuate the area if the spill is dangerous or unidentifiable. If the spill is not an immediate threat, try to find out what has been spilled and try to prevent the spilled material from going down a drain or onto the ground.

Please keep in mind the rules of waste management whenever cleaning up spills. In most cases, the cleanup materials used must be disposed of as regulated waste.

STUDY QUESTIONS

1. Questions regarding requirements for waste generation, packaging and shipping, or disposal should be addressed to

a. the facility manager
b. an RCT
c. a waste management coordinator
d. a supervisor

2. What does *not* have to be done when working with a chemical on site?

a. ensure that the chemical has secondary containment
b. label the chemical properly
c. locate the MSDS
d. know the rules of disposal

3. If you generate waste in a radiological area, you should

a. take the waste to the county landfill
b. store it at TA-53 for others to use
c. recycle it
d. call an RCT before it is removed from the radiological area

ANSWERS

1. c
2. a
3. d

HAZARDS AND HAZARD CONTROL

The objective of this section are that you understand

- the requirements for working with electrical equipment
- the purpose of each of the three types of lockout/tagout
- the sources of stored energy and the potential hazards that stored energy presents
- the requirements for working with chemicals
- the hazards involved in working with cryogens
- the hazards involved in working around magnets
- the hazards involved in working around lasers
- the industrial hazards present at TA-53 and how to observe the Cone of Safety
- the requirements for operating cranes and forklifts
- the characteristics of confined spaces and the potential hazards confined spaces present
- the difference between Restricted Access Areas and Limited Access Areas
- the five steps to follow to enhance the safety of your work
- techniques for controlling hazards

HAZARDS AND HAZARD CONTROL

ELECTRICAL HAZARDS

Because electricity is the main power source for the accelerator, the hazards that electrical energy present are probably the most common hazards at TA-53.

Electrical equipment can cause shocks, burns, and electrocution.

Before working on any equipment,

- locate the breakers or power sources
- disconnect the equipment
- lockout/tagout the equipment if possible

If you are a LANL employee or contractor and will regularly work on electrical equipment, you must be trained in the Laboratory's electrical training program.

Two-Person Rule

When one qualified electrical worker is working on exposed, energized electrical equipment, a second qualified worker must stand by. The second person is not to be assigned "hands on" tasks or duties but must be aware of the first person's tasks and be able to provide emergency assistance if needed. The second person must be knowledgeable about the equipment shutdown controls and disconnects and must be able to de-energize the equipment if necessary.

The two-person rule applies throughout the Laboratory.

Lockout/Tagout

Locks and tags are used to protect workers from sudden startups, stored energy, and moving parts. Although locks and tags are generally used in electrical work, there may be mechanical hazards that must be controlled by locks and tags.

Lockout is placing a lock on the device that controls the equipment (such as a power switch, circuit breaker, or release valve) so that the equipment cannot be operated until the lock is removed.

Tagout is placing a tag on the device that controls the equipment, indicating that the equipment must not be operated until the tag is removed. Tags are used alone only when the placement of a lock is not possible. Special approval is often required for tag only situations. Generally, both locks and tags are used.

Lockout/tagout.

Only trained, authorized personnel are allowed to attach or remove locks and tags from equipment. Other than brass access-control locks, you will see three different color combinations for locks and tags at TA-53:

- *Red locks and red tags* that read "DANGER—DO NOT OPERATE" are used to protect workers performing maintenance, making modifications, or servicing equipment with hazardous energy sources.

- *Blue locks and yellow tags* that read "CAUTION" are used for controlling the configuration of equipment and systems that pose no hazard to personnel safety but if operated, could cause damage to equipment.

- *Orange locks and orange tags* are used for protection of personnel who are not involved in system maintenance or modification but could be exposed to safety hazards solely because they are working in an area near hazardous energy sources.

Where lockout capability does not exist, tags are placed on equipment to indicate that the equipment should not be operated until the tag is removed.

DO NOT tamper with locks or tags. A person's life could be at stake.

STORED-ENERGY HAZARDS

Stored-energy hazards may be present when the following are in use:

- magnets
- cryogenic dewars
- high-pressure systems
- vacuum systems
- pressurized gas systems
- pressurized water systems
- gas cylinders

Stored energy presents the possibility of fire, explosions, asphyxiation, and even flying projectiles.

Refer to the standard operating procedures (SOPs) that outline the hazards and safety procedures to follow when working with equipment that could present a stored-energy hazard.

CHEMICAL HAZARDS

Solvents such as acetone and ethanol are used regularly at TA-53 for cleaning equipment. Cryogens such as liquid nitrogen and liquid helium are also common. Other more hazardous chemicals are also present on site, including carcinogens, corrosives, and toxic agents.

Before working with any chemicals,

- know the hazards of the chemicals you will use
- locate their Material Safety Data Sheets (MSDSs)
- label the chemicals
- use proper protective equipment
- know spill response procedures

CRYOGENIC HAZARDS

At TA-53, cryogens are regularly used to cool equipment and are used as beam targets. Cryogens are ultracold liquids, such as liquid helium, liquid nitrogen, and liquid hydrogen.

Some of the dangers of working with or around cryogens are

- cryogenic burns, if the cryogen comes into contact with human tissue
- asphyxiation, if large amounts of cryogens are released and oxygen is displaced. In certain areas, a low oxygen alarm will sound if this occurs.

Proper personal protective equipment is essential whenever working with or around cryogens. Special safety procedures must be followed whenever working with liquid hydrogen.

MAGNETIC HAZARDS

Magnets present a number of hazards, including electrocution and hazardous energy sources which can crush body parts or create projectiles. Because cryogens are often used to cool superconducting magnets, workers must be aware of cryogenic hazards as well as magnetic hazards.

Whenever working with or near powerful magnets,

- always assume magnets are powered
- do not work in the gap of an energized magnet
- avoid touching power cables and connections of an energized magnet
- do not go near magnets with ferrous or magnetic objects

Stay away from magnets if you have a pacemaker or other medical electronic devices.

LASER HAZARDS

Working around lasers may expose the eyes and skin to nonionizing radiation. In addition, some of the lasers at TA-53 present a high danger of electrocution.

Certain high-powered lasers are equipped with scram switches which will shut off power in case of an emergency.

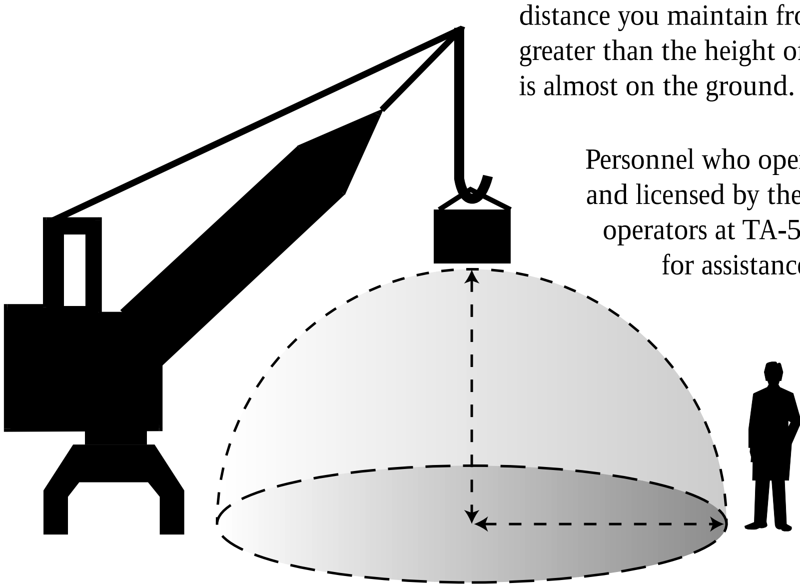
Whenever you approach an area with lasers,

- check the illuminated sign outside the area for laser status
- enter only with permission
- always obey the warning signs
- wear appropriate eye protection if required

Anyone working with or around Class III or Class IV lasers must complete the Laboratory Laser Safety Orientation before performing laser operations. Retraining is required every three years.

INDUSTRIAL HAZARDS

Crane and forklift operations present the main industrial hazard at TA-53. If you are in the area of a crane operation, always wear a hard hat and never get under the load. The "Cone of Safety" must be observed when in the area of crane operations: the distance you maintain from a suspended load should be equal to or greater than the height of the load. Do not approach the load until it is almost on the ground.



Cone of Safety.

Personnel who operate cranes and forklifts must be trained and licensed by the Laboratory. There are a number of licensed operators at TA-53. Contact the LANSCE Training Office for assistance in contacting authorized personnel.

Crane operators are categorized as either incidental or qualified operators. Lifts performed by incidental crane operators must not exceed 75% of the rated capacity of the crane or hoist, must not require special rigging, and must not consist of hazardous materials. Qualified crane operators are authorized to perform high-consequence lifts that exceed 75% of the rated capacity of the crane or hoist.

Retraining for forklift and crane operators is required every three years.

HAZARDOUS AREAS

Confined spaces

Work in confined spaces can be very hazardous. At LANL, there has been one death in a confined space. There are about 50 posted confined spaces at TA-53. Only trained, authorized workers should enter confined spaces.

The following are characteristics of confined spaces:

- space has limited or restricted means of entry and exit
- space is not designed for continuous occupancy by a worker
- a person can bodily enter the space
- permits for entry may be required
- the atmosphere in the space may be hazardous
- maneuvering in the space may require special equipment, such as a harness

Potential hazards in confined spaces may include

- oxygen-deficient atmosphere
- fire resulting from the use of flammable gases or liquids
- toxic vapors from liquids and chemical reactions
- engulfment

Only trained, authorized rescue personnel are allowed to perform confined-space rescues. Sixty percent of confined space fatalities are would-be rescuers. If an emergency rescue is necessary, immediately call 911 and wait for rescue personnel.

Restricted Access Areas

Restricted Access Areas are generally located in remote areas and are rarely visited. They are areas which are inaccessible when the LANSCE accelerator beam is on and where there may be residual radiological hazards when the beam is off.

Additional training is required for workers who need unescorted access to the following Restricted Access Areas:

- 201 and 805 Beam Lines
- Switchyard
- Proton Storage Ring
- Line D Tunnel
- Blue Room
- Target 4 Tunnel

The training does not allow uncontrolled access to these areas. In many cases there are keys or permits that must be obtained before entering these areas.

Limited Access Areas

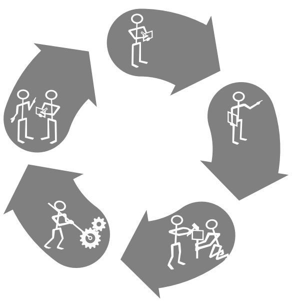
Limited Access Areas are located close to the LANSCE accelerator beam. Workers with a legitimate programmatic need to occupy a limited access area during normal beam operation are permitted to do so in order to access experiments, repair or troubleshoot problems with equipment, or perform maintenance and inspections of equipment.

Because of the proximity to the beam and the potential for a beam spill under certain accident conditions, workers who enter these areas must be aware of hazards which may be encountered.

Additional training is required for workers who need unescorted access to the following Limited Access Areas:

• Experimental Room 1 (ER-1) at the Manuel Lujan Jr. Neutron Scattering Center
• Compressor Trailer Area at the Manuel Lujan Jr. Neutron Scattering Center
• Mechanical Equipment Building (MPF-7)

HAZARD CONTROL



The Five-Step Process

The first line of defense to ensure a safe workplace is individual awareness and commitment to safe work practices. All work performed at Los Alamos must be appropriately planned and hazards analyzed before the work begins. To ensure that work is being performed as safely as possible, each activity at the Laboratory should be approached through the following five-step process:

1) Define the scope of the work, set performance expectations, and prioritize tasks.
2) Analyze hazards.
3) Develop and implement controls to prevent or mitigate hazards. Establish a safety envelope for your work.
4) Perform the work safely.
5) Identify how you might improve your performance the next time around. Reinforce smart work practices and implement changes to improve your performance.

If it comes to a choice between meeting programmatic commitments and doing work safely, safety always comes first!

Forklift and crane operations are a significant industrial hazard on site.

Techniques

The following are five techniques used to control hazards:

Elimination. Whenever designing a new procedure or operation, eliminating any apparent hazards should be a primary consideration. An industrial hygienist or safety engineer can assist you in evaluating your operation and can provide ideas on how you might eliminate hazards before you actually start work.

Substitution. Replace a highly hazardous material or operation with a less hazardous material or operation.

Engineering Controls. If the hazard cannot be eliminated or a substitute cannot be used, engineering controls can be used to mitigate hazards. For example, a fume hood could be used for better ventilation, or concrete blocks used for shielding. Safety devices can be used to monitor work areas and provide additional protection. For example, an oxygen alarm may sound when oxygen levels are dangerously low.

Administrative Controls. Administrative controls such as procedures, exposure limits, and work permits are used to ensure operations are conducted as safely as possible given various hazards. For example, some operations which may present the possibility of high exposures to radiation require a radiological work permit (RWP).

Hazardous operations on site have standard operating procedures (SOPs) which must be followed. SOPs outline the scope of an operation and the hazards involved.

Personal Protective Equipment. Personal protective equipment (PPE) is secondary protection that should be used after all other means of controlling the hazard have been put in place. PPE may include protective gloves, face shields, protective clothing, a hard hat, and safety shoes.

Check with the on-site industrial hygienist or safety engineer if you have questions about hazard controls for new or changing operations or if you have questions about existing controls.

STUDY QUESTIONS

1. A worker comes across a red lock on a machine. What should the worker do?

a. NOT touch the red lock and NOT work on the equipment
b. find a way to bypass the tag and proceed
c. replace the lock with a tag and proceed
d. remove the lock, proceed, then relock the machine

2. According to the Cone of Safety principle, if a crane load is 10 feet in the air, at a minimum, how far must you be from the suspended load?

a. 20 feet
b. 5 feet
c. 10 feet
d. it doesn’t matter as long as you have received approval to be in the area of a crane operation

3. Which item could pose a hazard as a worker goes near a magnet?

a. keys
b. wrench
c. gas cylinder
d. all of the above

4. In which kind of area could a worker potentially receive a high dose of radiation during improbable accident conditions?

a. confined space
b. Restricted Access Area
c. Limited Access Area
d. none of the above

5. What would you do if you came across another worker unconscious in a confined space?

a. Go in after him. Seconds count in a situation like this. He may need CPR.
b. Tell someone to call 911 and then go in after him. Give first aid or start CPR.
c. Immediately call 911 and wait for rescue personnel.
d. None of the above.

6. Before entering a Limited Access Area, a Restricted Access Area, or a confined space, before operating cranes or forklifts, and before working with hazardous chemicals or lasers, one MUST be ___________.

ANSWERS

1. a
2. c
3. d
4. c
5. c
6. properly trained

GENERAL PRINCIPLES OF RADIATION PROTECTION

The objectives of this section are that you understand

- the variety of sources of radiation that exist
- occupational radiation exposure limits set by the Department of Energy and TA-53
- the effects of exposure to radiation
- the ALARA concept
- the ES&H team's responsibilities and line managers' responsibilities for work in radiological areas

GENERAL PRINCIPLES OF RADIATION PROTECTION

RADIATION

We are exposed to radiation every day. Cosmic radiation from the sun, radioactive materials in the soil and rocks, and radiation from some forms of elements (such as potassium-40) within our bodies are all naturally occurring sources of radiation. This radiation is no different from the radiation emitted from manmade sources we may encounter in the workplace.

One way to evaluate the risk of working around radiation is to compare the average occupational radiation doses of workers who perform radiological work activities with workers who perform other types of work.

Average Occupational Radiation Dose

	rem per year	mrem per year
Airline flight crew members (cosmic radiation)	1.000	1,000
Nuclear power plant workers (radiological work activities)	0.700	700
Grand Central Station workers (building materials)	0.120	120
Medical personnel (patient treatment/diagnosis)	0.070	70
Department of Energy employees and site workers (radiological work activities)	0.044	44

(Reported in *Department of Energy Study Guides*, DOE/EH-0259T-2 Rev. 1, DOE/EH-0260T-2 Rev. 1, and DOE/EH-0261T-2 Rev. 1, May 1994.)

EXPOSURE LIMITS

There are exposure limits and administrative controls in place to minimize the risk of the biological effects associated with exposure to radiation.

Exposure Limits Set by the Department of Energy

The Department of Energy (DOE) has set limits on the maximum occupational radiation dose that workers, visitors, and the public are allowed to receive as a result of radiation exposure from DOE activities.

Annual Dose Limits for Radiological Workers:

- 5 rem per year to the whole body
- 15 rem per year to the lens of the eye
- 50 rem per year to the extremities
- 50 rem per year to the skin of the whole body
- 50 rem per year to specific organs and tissue
- 0.5 rem total for the term of pregnancy (limit for an unborn child)

Annual dose Limit for visitors, the public, and general workers:

- 0.1 rem per year

Exposure Limits Set by TA-53

- 1.5 rem per year for radiation workers involved in maintenance or operational activities where exposures are expected and the work requirements are specified in a radiological work permit (RWP)
- 0.5 rem per year for all other radiation workers

EFFECTS OF RADIATION EXPOSURE

Biological Effects

Radiation damage to the human body begins with damage to the atoms that make up human cells. The biological effects of radiation are either somatic or genetic. Somatic effects appear in the worker. Genetic effects appear in the offspring of the exposed worker.

There is the possibility of contracting cancer or leukemia as a result of long-term exposure to low levels of radiation (chronic) or short-term exposure to very high levels of radiation (acute).

Several factors contribute to the biological effects of exposure to radiation:

- total dose received
- duration of exposure
- area of body exposed
- individual sensitivity
- type of radiation

Potential Effects of Prenatal Exposure

The rapidly dividing cells of an embryo or fetus make them sensitive to radiation. Some risks to a developing fetus may include

- low birth weight
- small head size
- mental retardation
- increased chances of childhood cancer

Radiation exposure for pregnant radiological workers cannot exceed 0.5 rem, or 500 mrem, for the term of the pregnancy. In most cases, exposures are kept significantly lower than this limit. Pregnant radiological workers are encouraged to report their pregnancy to their supervisor or to the Occupational Medicine Group so that job modifications can be made if necessary.

ALARA—AS LOW AS REASONABLY ACHIEVABLE

One of the ways radiation workers are protected at the Laboratory is through the ALARA philosophy, or keeping doses "as low as reasonably achievable." ALARA incorporates three important parts:

- maximize your distance from the source of the radiation
- minimize the time you spend near the source
- shield the source of the radiation

YOU are the key to a successful ALARA program. Please

- cooperate with the radiological control technicians (RCTs)
- obey all postings and entry requirements

The lower you keep your exposure, the lower your risks will be.

If you have concerns about the radiological conditions in your work area, call the RCTs at the ESH-1 TA-53 Team Office (7-7069) so that they can take the appropriate steps to ensure your exposure to manmade radiation remains ALARA.

RESPONSIBILITIES

Responsibilities of Environment, Safety, and Health Professionals

The TA-53 Environment, Safety, and Health (ES&H) team, with the support of ESH Division, provides

- external and extremity dosimetry
- internal dose assessment
- operations radiation protection support
- assistance in implementing Laboratory policies and procedures for radiation work

Responsibilities of Line Managers

Line managers are responsible for

- implementing radiation protection requirements
- identifying radiation workers under their supervision
- ensuring that workers receive the necessary safety training to do their jobs
- providing a safe workplace

STUDY QUESTIONS

1. One way to reduce your external radiation dose is to

a. remove radiation signs that you think are unnecessary
b. decrease the time spent in a radiation area
c. wear proper dosimetry
d. decrease distance from the source of radiation

2. Factors affecting biological damage from radiation exposure include

a. total dose received
b. time of exposure
c. area of body exposed
d. all of the above

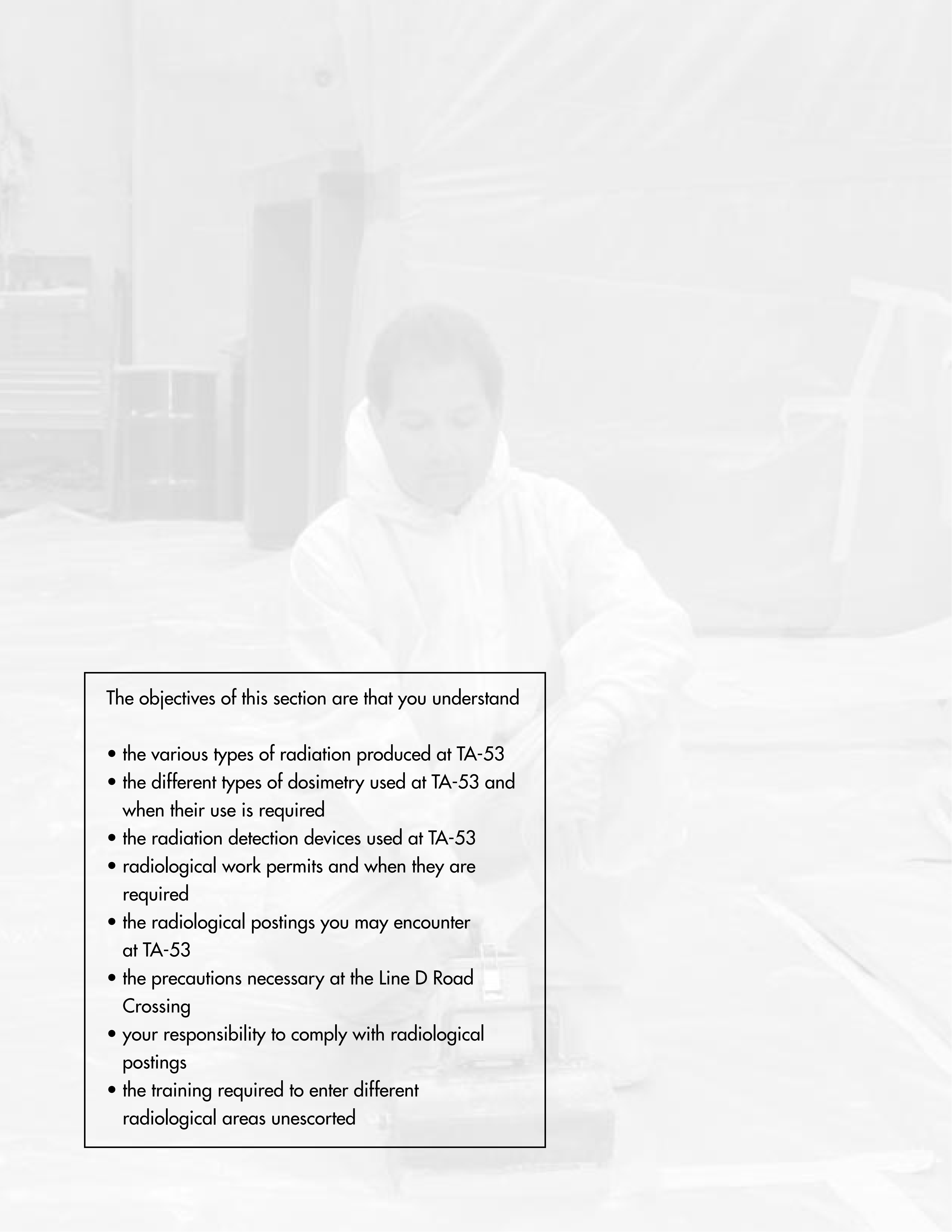
3. __________ effects appear in the offspring of the exposed worker.

a. Somatic
b. Acute
c. Chronic
d. Genetic

ANSWERS

1. b
2. d
3. d

FACILITY-SPECIFIC RADIATION PROTECTION GUIDELINES



The objectives of this section are that you understand

- the various types of radiation produced at TA-53
- the different types of dosimetry used at TA-53 and when their use is required
- the radiation detection devices used at TA-53
- radiological work permits and when they are required
- the radiological postings you may encounter at TA-53
- the precautions necessary at the Line D Road Crossing
- your responsibility to comply with radiological postings
- the training required to enter different radiological areas unescorted

FACILITY-SPECIFIC RADIATION PROTECTION GUIDELINES

TYPES OF RADIATION

At TA-53, the types of radiation that are produced by the proton beam's interaction with targets or as by-products of the beam activity include beta and gamma radiation, x-rays, and neutron radiation. In addition, some alpha radiation emitters are used in experiments or produced in targets.

Beta and Gamma Radiation

Beta and gamma radiation are produced from

• the interaction of the accelerated beam with targets
• radioactive decay of material which has been in the beam line
• radioactive targets or sources used around TA-53

Lead, steel, or concrete is used to shield against beta and gamma radiation.

When the beam is turned off, beta and gamma radiation remain in the form of activation or activated products. Even if the beam is shut down, do not assume that there are no radiation hazards. Beta and gamma radiation levels are highest right after the beam is turned off and decrease over time. To ensure that radiation levels are low enough so that they do not pose a hazard, check with a radiological control technician (RCT) before entering certain beam areas after the beam has gone down. Be aware of the radiological postings in these areas: they should reflect current beam conditions.

NOTE: In Area A, the beta and gamma radiation levels may be higher during maintenance periods because of the opening of target cells.

X-Rays

X-rays are produced primarily by

• the operation of the klystrons, which produce the radio-frequency power used in the acceleration process
• beam separators used to separate different species of charged particles
• accelerating tanks where radio-frequency waves are used to accelerate the beam

Thin layers of lead, steel, or concrete will stop most x-rays. Areas where x-rays are generated are monitored regularly. X-rays are mostly of concern around klystrons and during maintenance periods when equipment is being conditioned before startup.

Neutron Radiation

Neutrons are produced when the proton beam interacts with targets and components in the beam line. Neutrons are produced only while the beam is on, but neutrons can cause nonradioactive material to become radioactive, or activated. Neutrons are also produced by sealed sources used to check neutron-monitoring instruments.

Neutron radiation is of concern primarily in the experimental areas. However, activation from neutrons should be expected any time the proton beam has the possibility of interacting with beam-line components. The intensity of the radiation depends on the beam energy and the material with which the beam interacts.

Concrete and polyethylene are the primary materials used for shielding; however, steel is also used for shielding of very high energy neutron radiation.

DOSIMETRY

Radiation cannot be detected with any of the human senses. To accurately determine radiation doses, a variety of special detection and dosimetry devices are used throughout the Laboratory.

Workers may be exposed to external sources of radiation. With this type of exposure, the radiation dose is reduced as the person moves away from the source of the radiation. In the case of contamination, the person carries the source of the radiation with them. Workers may become contaminated by inhaling or ingesting radioactive material or by getting radioactive material on their clothing.

The following kinds of dosimetry are used at TA-53.

Thermoluminescent Dosimeter

The thermoluminescent dosimeter (TLD) is the primary device used to measure external radiation dose from sources outside the body. You will be issued a TLD following this training.

- Wear your TLD at all times while on site at TA-53.
- Wear the TLD in the chest area, well above the waist.
- Wear it front forward (one side will say, “This side toward chest”).
- Take your TLD home with you—do not leave it on site.
- Do not leave the TLD on the dashboard of your car as this will affect the dose reading.
- Do not wear it to medical or dental x-ray sessions.
- Do not put it through an airport x-ray machine.
- Exchange your TLD at the beginning of each month.

Personal Neutron Dosimeter

The PN-3 personal neutron dosimeter measures neutron dose from higher energy neutrons not detected by the TLD. The PN-3, or "Lemon Badge," is required for work in all experimental areas when the beam is on and is worn in addition to a TLD. The badge must be worn above the waist, with the flat side to the chest. PN-3 personal neutron dosimeters are exchanged quarterly.

Pocket Chambers and Electronic Dosimeters

Pocket chambers and electronic dosimeters provide a direct readout of gamma radiation exposure; they are used to keep track of immediate radiation exposure on hot jobs. They are generally issued whenever you will be working in an area where you are expected to receive at least 10 mrem per hour exposure to your whole body. Please inform the RCT if you drop a pocket chamber because the dose reading may be substantially increased by dropping it.

If you require a supplemental dosimetry device, you will receive specific instructions on how to read and wear it.

Internal Dosimetry

Whole body counts are scheduled if you could potentially ingest or inhale gamma-emitting radioactive material. Whole body counts may be done annually or in special cases. For alpha or beta emitters, urine or fecal samples are taken for analysis. Nasal smears are taken any time you are required to wear a respirator or when it is possible that you may have inhaled radioactive particulates. If you get positive nasal swipe results, you will be required to get a whole body count. Anyone who works in a contamination area or wears a respirator for radiological purposes should have an annual whole body count.

RADIATION DETECTION DEVICES

The following types of radiation monitors are used at TA-53.

Portal Monitors

Portal monitors detect external contamination. If a portal monitor alarm should go off, stay in the area and call an RCT immediately.

Neutron Detectors

Neutron detectors are used to detect elevated levels of neutron radiation. There are two types of neutron detectors used at TA-53. Albatross monitors are used in Limited Access Areas throughout the facility. RM-16 neutron detectors are used in different areas on site. If either type of alarm should sound, immediately evacuate the area and call an RCT.

Gate Alarm

There is a radiation detection system at the main gate of TA-53. If radioactive materials set off this alarm, a red light will come on and an alarm will sound. If this happens, pull your vehicle over and stop, then call an RCT.

Be aware that the radiation detector and alarm at the gate are not effective for tritium and certain other isotopes. If you will be transporting tritium samples or tritium-contaminated materials or equipment, you must have the items checked by an RCT before removing them from the controlled area.

The alarm is sensitive enough to detect medical isotopes you may have received. If you have recently received a medical radioisotope treatment or are transporting radioactive materials call ESH-1 (7-7069) before leaving TA-53.

Continuous Air Monitors

Continuous air monitors (CAMs) are used in various areas to monitor the levels of airborne radioactivity. If a CAM alarm or other air monitor alarm should go off in an area where you are working, immediately leave the area and call a RCT. Do not blow your nose after evacuating a CAM alarm area. The RCT may need to take a nasal smear to check for contamination.

RADIOLOGICAL WORK PERMITS

Radiological work permits (RWPs) are required for operations where the total exposure to workers could be greater than 100 mrem, such as in a high or very high radiation area or in a contamination area in which a standard operating procedure (SOP) does not address radiological hazards in the area.

For example, work in the target cells and work in the beam-stop area both require an RWP, as does any work with radioactive materials. An RWP is not required if a worker enters one of these areas to take a measurement, then quickly exits, but these short entries must be cleared with an RCT each time.

An RWP is required for

- work involving the removal of radioactive or contaminated accelerator parts
- operations involving machining, grinding, burning, or welding radioactive sources or irradiated materials in which the contact radiation level is greater than 0.5 mrem per hour
- operations which require personal protective equipment (PPE) to guard workers against radioactive material
- cleanup operations, including janitorial work in the beam channels, switchyard, main beam lines, or west hot-cell area
- operations or experiments involving a Class I radioactive research source

RADIOLOGICAL POSTINGS

Areas controlled for radiological purposes have signs posted with a magenta or black radiological trefoil symbol on a yellow background. Barriers around radiation areas are formed by ropes with warning signs hanging from them or by yellow and magenta tape.

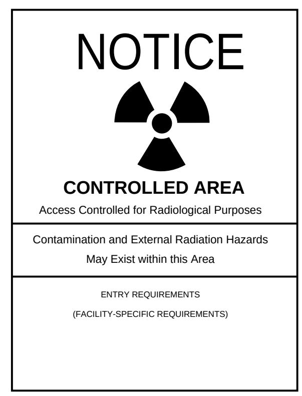
Postings in some areas change considerably between periods when the beam is on and periods when the beam is off for maintenance or during scheduled shutdowns. For example, an area may be posted as a very high radiation area when the beam is on and may be posted as a radiation area when the beam is not operational.

You may encounter the following radiological postings at TA-53.

An RCT placing a radiological posting in Experimental Area A.

Controlled Areas

A controlled area is an area of relatively low radiological risk. Access is controlled to protect individuals from exposure to external radiation or contamination. General Employee Radiological Training (GERT) is required for entrance to controlled areas. Dosimetry is normally required. There are three different types of radiologically controlled area (RCA) designations:



RCA for External Radiation. In this type of controlled area, a reasonable potential exists for an individual to receive more than 0.1 rem during a year from external radiation fields.

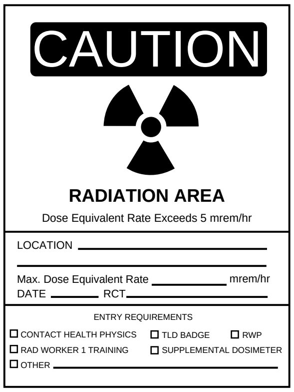
RCA for Contamination. In this type of controlled area, a reasonable potential exists for an individual to receive more than 0.1 rem committed effective dose equivalent during a year from intakes, or a reasonable potential exists for contamination to occur at other specified levels.

RCA for Volume Contamination. A reasonable potential exists for the presence of contaminated materials that are not individually labeled.

Radiological Buffer Area

A radiological buffer area surrounds or is contiguous with radiological areas that contain radiological hazards, such as radiation, contamination, and airborne radioactivity. Access to a radiological buffer area is controlled to protect individuals from exposure to external radiation or contamination. Radiological Worker I or II training is required for unescorted access, and a dosimetry badge is required.

Radiation Area



This designation indicates an area in which radiation dose rates are greater than 0.005 rem per hour, but less than or equal to 0.1 rem per hour. Radiological Worker I or II training is required, and a dosimetry badge is required.

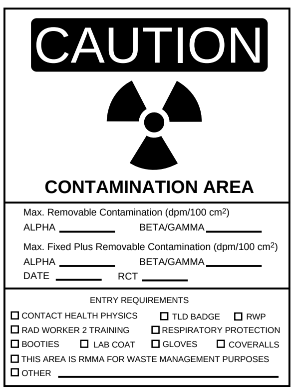
High Radiation Area

This designation indicates an area in which radiation dose rates are greater than 0.1 rem per hour but less than or equal to 500 rad per hour. Access to high radiation areas is administratively controlled by locks or interlocked barriers. Radiological Worker II training is required, as well as appropriate dosimetry and an RWP.

Very High Radiation Area

This designation indicates an area in which radiation dose rates are greater than 500 rad per hour. Radiological Worker II training is required as well as dosimetry and an RWP. Access to very high radiation areas is controlled by the ESH-1 TA-53 field team.

Contamination Area



This designation indicates an area in which contamination levels exceed specific limits. Levels and entry requirements are posted for these areas. Radiological Worker II training, a dosimetry badge, Level I protective clothing, and an RWP are required. Eating, drinking, and chewing gum or tobacco are prohibited.

High Contamination Area

This designation indicates an area in which contamination levels are greater than 100 times the limits that define a contamination area. Contamination levels and entry requirements are posted. Radiological Worker II training, dosimetry, Level II protective clothing, and an RWP are required.

Airborne Radioactivity

There are two postings associated with airborne radioactivity that you may see at TA-53. Airborne radioactivity postings are for both radioactive gas and airborne radioactive particulates. Radioactive gases are an external radioactive hazard while particulates can be inhaled or ingested and are therefore an internal hazard. Posted signs will describe the hazards and any entry requirements.

Radioactive Material Fixed Contamination

The two Radioactive Material Fixed Contamination postings show what the contamination conditions are in the posted area.

Localized Hot Spot: External Radiation

This is a localized source of radiation or radioactive material in which the radiation level of the hot spot is greater than 100 mrem per hour on contact and is more than five times the general area radiation level. Entry requires an RWP.

LINE D ROAD CROSSING

The Line D beam line passes under the roadway as it is transported from the switchyard to the Proton Storage Ring and the Weapons Neutron Research (WNR) facility. At this location, a beam-spill accident could potentially cause dose rates in excess of 100 rem per hour. This is an extreme and unlikely scenario; however, do not loiter in the area of the Line D road crossing when the beam is on to the Manuel Lujan Jr. Neutron Scattering Center or to WNR. Shielding blocks line both sides of the road crossing and radiological conditions are posted.

COMPLYING WITH RADIOLOGICAL POSTINGS

It is each person's responsibility to read and comply with radiological postings, signs, and labels. You should take every precaution to protect yourself, your co-workers, and the general public from unnecessary exposure to radiation.

Disregarding any postings or removing or relocating them without permission could lead to

- unnecessary or excessive radiation exposure
- personnel contamination or injury
- release of contaminated or radioactive materials into the environment
- loss of privileges or termination

In a radiological area,

- ALWAYS read the signs as you enter
- always comply with standard operating procedures (SOPs) or radiological work permits (RWPs)
- NEVER climb the shielding walls of the experimental areas when the beam is on
- do not prop ladders against shielding walls

TRAINING REQUIREMENTS FOR ENTERING RADIOLOGICAL AREAS

Listed below are the training courses required for entry into different radiological areas. Workers who do not have the appropriate radiological worker training for the areas they will be entering must be continuously escorted by a trained worker.

General Employee Radiological Training	Radiological Worker I	Radiological Worker II
Controlled Areas	Controlled Areas	Controlled Areas
	Radiological Buffer Areas	Radiological Buffer Areas
	Radiation Areas	Radiation Areas
		High Radiation Areas
		Very High Radiation Areas
		Contamination Areas

STUDY QUESTIONS

1. Laboratory signs for radiological areas are

a. magenta and yellow
b. magenta and white
c. black and yellow
d. a or c

2. TLDs are required for

a. people who work only in the experimental areas
b. people who work in all areas at TA-53
c. only long-term residents at TA-53
d. people who work only in certain areas at TA-53

3. If you are issued a TLD, you must

a. wear it only when you think necessary
b. wear it near your waist
c. leave it on site when you go home
d. none of the above

4. The PN-3 dosimeter badge, or “Lemon Badge,” is used to measure which type of radiation?

a. neutron
b. gamma
c. alpha
d. beta

5. Radiological areas at TA-53

a. never change
b. are posted differently when the beam is off than when the beam is on
c. are not posted when the beam is off
d. are areas in which radiation doses never exceed 5 mrem per hour

6. For measuring immediate radiation exposure on hot jobs, which type of dosimeter is used?

a. TLD
b. PN-3
c. Pocket Chambers or Siemens
d. none of the above

7. If you lose your TLD, you should

a. wait at least a week before reporting it as missing
b. have your group secretary issue you another one
c. not go into any radiological areas until the beginning of the next month
d. report the loss to ESH-1 and pick up a temporary badge

8. The minimum training required for access to a High Radiation Area is

a. Radiological Worker I
b. General Employee Radiological Training (GERT)
c. TA-53 Facility-Specific Training
d. Radiological Worker II

ANSWERS

1. d
2. b
3. d
4. a
5. b
6. c
7. d
8. d

EMERGENCIES

The objectives of this section are that you understand

- how to respond to an emergency
- the alarms used at TA-53
- the function of emergency evacuation posters
- where to get emergency medical care
- the requirements for using a fire extinguisher

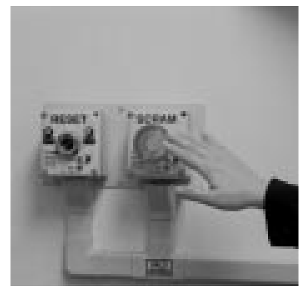
EMERGENCIES

RESPONDING TO AN EMERGENCY

In the event of an emergency, your own safety should always be your first priority. If you are the first person on the scene, call 911. If you call from a cellular phone, DO NOT dial 911 but rather call the Laboratory's Emergency Management and Response team at 667-6211. (If you call 911 from a cellular phone, your call will be automatically routed to Santa Fe.)

ALARMS

A number of alarms are used at TA-53. Alarms vary depending on the hazards present and the area.



A scram switch shuts off the accelerator beam.

Alar m	Response
Fire Alarm	Evacuate the building or area and report to the assembly area.
Low Oxygen Alarm	Immediately evacuate the building or area.
Evacuation Alarm	Evacuate the building or area and report to the assembly area.
Continuous Air Monitor Alarm	Immediately evacuate the building or area, then call a radiological control technician (RCT) at 7-7069.
Sweep Horn	Hit the scram switch if you are in the beam channel or cave. The scram switch shuts off the accelerator beam. If you are not in the beam channel or cave, immediately evacuate the area.
Radiation Alarm at LANSCE Gate	Pull over to the side, then call an RCT.

EMERGENCY EVACUATION POSTERS

In each building at TA-53, an emergency evacuation poster is posted showing the evacuation routes and assembly areas for that building. Emergency phone numbers are also listed. When you work in an unfamiliar building, please take a moment to study the emergency evacuation map for that building.

EMERGENCY MEDICAL CARE

In the event of a major medical emergency, call 911 and ask for an ambulance or take the person directly to the Los Alamos Medical Center. If you call from a cellular phone, DO NOT dial 911; call 667-7080 for an ambulance.

In the event of a minor medical emergency, University of California employees should go to the Occupational Medicine Group, TA-3, Building 409. Contractors should go directly to the Los Alamos Medical Center for medical treatment.

FIRE EXTINGUISHERS

Fire extinguishers are located in all buildings. Only workers who have been specifically trained in how to use a fire extinguisher should attempt to fight a fire, and they should only do so if they can safely fight the fire, maintaining a clear exit path.

STUDY QUESTIONS

1. A worker is filling a dewar when it accidentally tips over. The low oxygen alarm goes off. What should the worker do?

a. try to clean up the spill
b. go get a self-contained breathing apparatus
c. evacuate the building
d. pull the fire alarm

2. You should only attempt to fight a fire with a fire extinguisher if

a. your supervisor instructs you to
b. you have read the instructions on the fire extinguisher
c. you have been properly trained to do so
d. none of the above

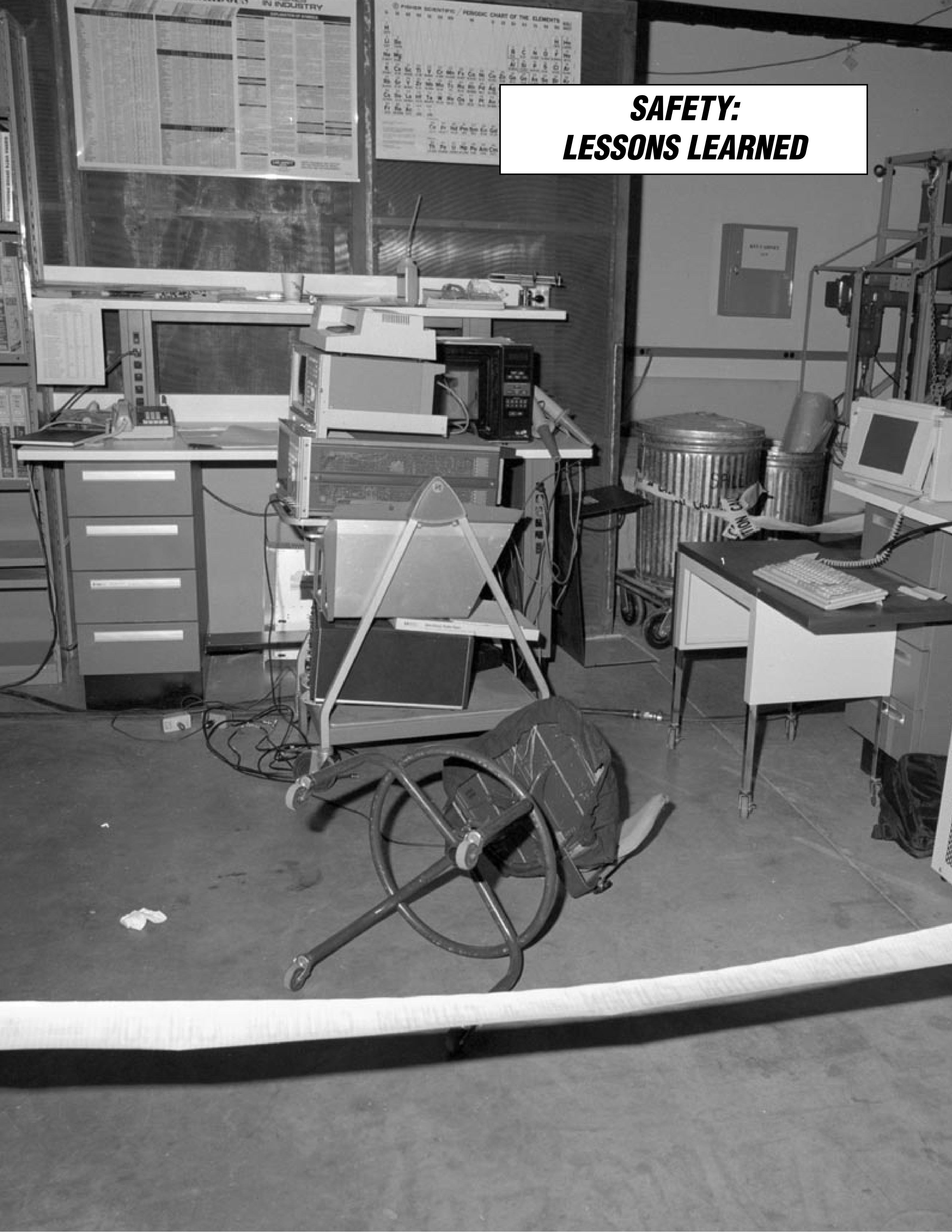
3. If the radiation alarm at the main gate goes off as you drive through, you should

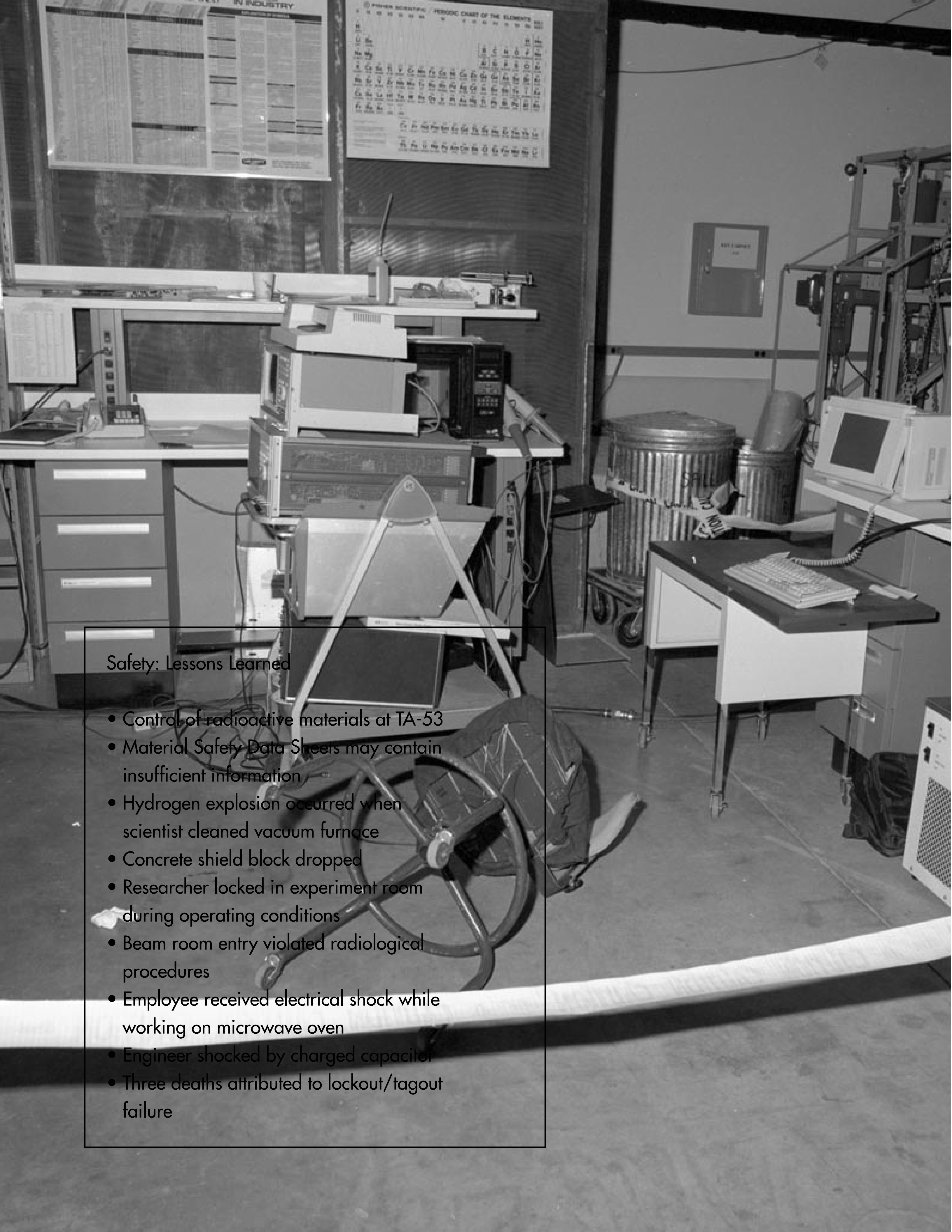
a. get out and inspect your vehicle; if all seems well, then continue
b. wait for the gate attendant to survey your vehicle
c. pull over to the side of the gate and call an RCT
d. go to the ESH-1 team office and have one of the RCTs monitor your vehicle

ANSWERS

1. c
2. c
3. c

SAFETY: LESSONS LEARNED





Safety: Lessons Learned

- Control of radioactive materials at TA-53
- Material Safety Data Sheets may contain insufficient information
- Hydrogen explosion occurred when scientist cleaned vacuum furnace
- Concrete shield block dropped
- Researcher locked in experiment room during operating conditions
- Beam room entry violated radiological procedures
- Employee received electrical shock while working on microwave oven
- Engineer shocked by charged capacitor
- Three deaths attributed to lockout/tagout failure

SAFETY: LESSONS LEARNED

CONTROL OF RADIOACTIVE MATERIALS AT TA-53

On Wednesday, October 8, 1997, it was determined that three vacuum pumps shipped off site from TA-53 for maintenance may have contained tritium-contaminated oil.

Seven vacuum pumps had been surveyed and were to be shipped to Albuquerque for maintenance. The initial survey results were received on June 18, 1997. The survey results were questionable and aliquots of the original samples were returned for re-analysis. In July, the group in charge of the pumps called ESH-1 to determine if the sample results had been received. Through a communication error, the group representative thought that ESH-1 gave verbal approval for the shipment of the pumps, even though the pumps did not have release tags. The pumps were shipped to Albuquerque by government vehicle on July 17, 1997.

When another group member received the written results of the analysis on October 8, 1997, he discovered that three of the seven pumps had results indicating the presence of tritium. Five of the seven pumps had been returned, including two of the three possibly contaminated pumps. The third, and potentially most contaminated, pump was still in Albuquerque.

A special team from Los Alamos National Laboratory (LANL) was dispatched to the vendor in Albuquerque on October 9, 1997. The work area and tools were surveyed, and results indicated no contamination present. The pumps and all the oil recovered from the seven pumps were collected, returned to Los Alamos, and surveyed. Results indicated no detectable contamination.

This was a “near miss” with serious potential consequences. In the worst case, vendor employees and the vendor’s shop in Albuquerque could have been contaminated. Had that occurred, work at TA-53 could have been suspended and operations subjected to a thorough review before restart, as recently happened at the Chemistry and Metallurgy Research facility at LANL.

Lessons Learned

With radioactive material movements at TA-53 numbering thousands per year, controls must be highly effective to reduce the frequency of this type of occurrence to near zero. Anyone working at TA-53 should know about and adhere to the following guidelines:

- Look for, read, and follow posted exit requirements when you leave any type of radiologically controlled area. Contact a radiological control technician (RCT) for a survey when indicated.

- Any potentially radioactive material MUST have a Health Physics Release Tag attached before release to an uncontrolled area. Pay particular attention to the status of off-site shipments.

- Areas posted as "controlled for volume contamination" may contain items that are activated. This posting is similar to "controlled for external radiation." Take note of the fine print!

- Be aware that the radiation detector and alarm at the TA-53 exit gate are not effective for tritium and certain other isotopes.

MATERIAL SAFETY DATA SHEETS MAY CONTAIN INSUFFICIENT INFORMATION

In mid June, 1997, news surfaced about a professor's death at Dartmouth College as a result of dimethylmercury poisoning. This prompted the cleaning of a laboratory at Oak Ridge National Laboratory after a container of carbon-14 tagged methylmercury iodide was found.

Because of the tragic outcome of the Dartmouth incident, concern was raised about the handling and disposal of the particular alkyl mercury compound found in the lab at Oak Ridge National Laboratory. An effort was initiated to dispose of the methylmercury iodide. The Material Safety Data Sheet (MSDS) was referenced for personal protection and handling guidance, but key information was not included in the MSDS.

Although the MSDS correctly stated that methylmercury iodide is highly toxic if inhaled, if it contacts the skin, or if swallowed (and may cause cancer and extensive central nervous system and kidney damage), the MSDS offered only general information for personal protection and handling.

In the process of reviewing other sources, important characteristics with respect to the rate of decomposition of carbon-14 tagged methylmercury iodide were noted. The MSDS made no mention of the rate of decomposition, although it did include the statement, "The chemical and physical properties of this material have not been thoroughly investigated."

Dimethylmercury (the compound used by the professor at Dartmouth) has also been used at LANL. Although the MSDS explicitly warns of the extreme hazards and severe consequences of exposure to this compound, it makes no recommendations on specific types of gloves or respirators to use for protection. The use of the wrong type of gloves is believed to have led to the death of the Dartmouth professor.

Lessons Learned

These incidents emphasize the limitations of depending solely on MSDSs for information on chemical characteristics and for recommendations on specific types of personal protective equipment. A study funded by the Occupational Safety and Health Administration found that only 11% of the MSDSs studied had presented completely accurate information and that the three categories with lowest accuracy were the categories critical in providing information necessary to protect the worker.

Although labeling and MSDSs are useful for assisting in the recognition of extremely hazardous chemicals, the properties of such chemicals should be evaluated thoroughly before they are used. When specific handling and storage instructions are not readily available on the MSDS, other sources should be checked. Health and safety professionals may need to be consulted for proper guidance on personal protective equipment.

HYDROGEN EXPLOSION OCCURRED WHEN SCIENTIST CLEANED VACUUM FURNACE

At LANL, a hydrogen explosion occurred when Fantastic spray cleaner, which is 87% water, was sprayed onto the interior surface of a high-temperature vacuum furnace top that was coated with magnesium.

The furnace top was sitting on the floor when the technician sprayed it with Fantastic. He then stepped away from the equipment to locate a vacuum cleaner. The explosion occurred seconds after he moved.

The ignition source is thought to have been either a static discharge spark generated by the technician's movements, the heat of the chemical reaction, or the presence of an oxidizer in the cleaner.

Lessons Learned

It is important to be aware of potential reactions that could occur when using chemicals in untested applications or new circumstances.

CONCRETE SHIELD BLOCK DROPPED

On October 15, 1992, 22-ton concrete shielding blocks were being moved out of Experimental Area A at TA-53 to provide access to target cell A2. The blocks were rigged to the bridge crane using two eyebolts which were fastened by four shackles to a strongback.

The incident occurred when the riggers inserted their eyebolts into the third block to be moved. The load was lifted clear of the obstacles around it, and the riggers moved away from the path of the block.

The entire load had traveled several feet when one eyebolt pulled out of the block. At this point, the block was suspended by one eyebolt shackled to the strongback, approximately 25 feet above the ground. When the free end of the block dropped to a point approximately 2 feet below the shackled end, the second eyebolt pulled out. The block then fell, and tumbled end-over-end toward the north end of area A, landing in the P3-West experimental area.

The block struck guard rails, experiment tables, building and experimental utilities, and one arm of the Neutral Meson Spectrometer. The estimated property loss was approximately $470,000.

A shielding block being moved by crane in Experimental Area A.

Lessons Learned

Ensuring that the eyebolts were inserted to an adequate depth could have been done readily and at little cost. Most likely, this check would have been done if the understanding of the properties of the lifting system had been current within the using group.

It is important to conduct a thorough inspection of all rigging assemblies. For example, screws and anchors should be inspected for degraded condition and to make sure they were properly installed.

The lack of appreciation of risk to valuable equipment can lead to unnecessary damage.

RESEARCHER LOCKED IN EXPERIMENT ROOM DURING OPERATING CONDITIONS

On November 15, 1995, a LANL researcher was locked in an experiment room at the LANSCE Accelerator Complex during operating conditions when entry is prohibited. Another researcher performed a sweep-and-lock procedure of the room and notified control center operators that the room was clear of all personnel. However, he had overlooked someone. The locked-in researcher was able to exit the room by activating a safety override. To prevent exposure to radiation, personnel are not allowed in the room when the Weapons Neutron Research beam is in operation.

Two researchers and a student were authorized to enter Experimental Room 1 at the Manuel Lujan Jr. Neutron Scattering Center for 30 minutes to tend their experiments on the flight paths. One of the researchers was designated as the Experimental Room 1 Entry Responsible (EER) person and was assigned responsibility for entry, clearing the room within the specified time, securing the room, and notifying control center operators that the room was secure.

With six minutes remaining in the entry time, the researcher designated as the EER initiated the exit sweep-and-lock procedure. He discussed exiting the room with the other researcher and the student as they completed their work. Although the EER did not direct the second researcher to perform a sweep, the second researcher believed he should assist in the sweep. The EER also forgot to make the local safety sweep announcement required by the procedure. The EER continued his sweep to the west and north doors. In the meantime, the second researcher completed his work and instructed the student to exit and stand outside the south tunnel door. He then proceeded to the west door as part of his sweep. When he reached the master indicator panel, he noticed that the lock procedure was complete and the doors secured. He ran back to the south door and activated an override to exit.

The second researcher was locked in the room for five minutes at the most, during which time control center operators had been notified to resume beam operations. An operator noticed the south door override activation and performed the sweep-and-lock procedure again. He found the room empty. The EER, the second researcher, the student, and the operator immediately notified their respective supervisors, who notified facility managers.

The managers issued an order that only qualified accelerator operations and technical support operators would perform room sweeps before resuming Weapons Neutron Research beam operations. Managers reviewed the event and determined that the locked-in researcher would not have received a significant radiation dose.

Lessons Learned

This event underscores the importance of positive, formal verification that all personnel have left an area when failure to do so could result in radiation exposure or injury. Visual verification is the most positive method and should be used.

Using a single point of entry and exit and a designated central meeting point can also enhance control, as can alarms, horns, or public address system announcements.

BEAM ROOM ENTRY VIOLATED RADIOLOGICAL PROCEDURES

On September 19, 1995, two employees violated radiological control procedures when they entered a beam room at the LANSCE Accelerator Complex without a radiological control technician (RCT) and before required radiological surveys were conducted. In addition, one of the employees did not wear required personal dosimetry. Based on surveys of the room, the amount of time they were in the room, and the areas of the room they occupied, Health Physics technicians determined that neither employee received an appreciable dose of radiation.

The blue room has two levels. Particle beams pass through equipment on the ground level. The lower level is used for storage. Because a particle beam produces very high radiation fields in the room, a hardware interlock, which is part of the personnel security system, prevents anyone from entering the room during beam operations. The radiation fields produced by the beam activate equipment in the room, and the activated equipment produces a radiation field even when the beam is off. Therefore, access to the room is administratively controlled by control room operators through the personnel security system when the beam is off. Administrative controls require Health Physics technicians to be present when the blue room is first entered after beam operation, to survey the room and post radiation hazard warnings.

On September 18, 1995, the day before the occurrence, operators turned off the beam passing through the blue room, but because the room remained secured, radiological surveys were not performed. On September 19, a Neutron Science and Technology employee (E1) wished to show another employee (E2) the layout of equipment in the blue room. E1 had several years experience with operations in the room. E2 was new to the group and not familiar with blue room operations.

E1 requested access to the blue room from the LANSCE control room. A control room operator asked E1 if he had an RCT with him. E1 replied that he did not, but the operator granted E1 and E2 access to the room. After walking around the ground level for a few minutes, E1 and E2 proceeded to the lower level, where they walked around for another few minutes before returning to the ground level. There, an RCT observed the employees in the room without an RCT escort. The RCT knew that the required radiological surveys of the room had not yet been performed, and the RCT also noted that E2 was not wearing a thermoluminescent dosimeter (TLD). The RCT directed E1 and E2 to exit the blue room, then the RCT began surveying the room. He measured radiation fields in the room ranging from 5 to 60 mrem per hour and, in a small area on beam transport equipment, he measured 160 mrem per hour at 30 centimeters and 60 mrem per hour at one meter.

During a critique the next day, September 20, the control room operator stated that he wrongly assumed the blue room had been surveyed when he granted E1 access to the blue room. E1 stated that, in retrospect, he was aware of entry requirements and should have known not to enter without a Health Physics escort. He also stated that he should have noticed that E2 was not wearing required personal dosimetry.

This event is significant because E1 and E2 could have received an additional radiation dose if they had stayed in the room longer, entered sooner after beam operation when radiation fields were higher, or spent more time in areas with high local radiation levels. The control room operator assumed, but did not verify, that the required surveys had been conducted. Although he was experienced, E1 did not stop and question the need for a Health Physics escort, even when asked about it by the operator.

Lessons Learned

The physical and administrative controls intended to prevent this type of event failed because of personnel errors. This event shows how important it is that employees understand and abide by the procedures for entry into radiological areas.

EMPLOYEE RECEIVED ELECTRICAL SHOCK WHILE WORKING ON MICROWAVE OVEN

On July 11, 1996, at the LANSCE Accelerator Complex, an employee received a severe electrical shock that knocked him to the floor and left him unconscious. The employee was working on a commercial microwave oven equipped with a standard 120-volt power supply when the shock occurred. Although others were working nearby, no one observed the incident. After the injured employee was discovered, an emergency medical team transported him to the Los Alamos Medical Center where he was placed in intensive care. The employee regained consciousness and recovered.

Investigators determined that the employee was characterizing the electrical voltages of a magnetron tube in a microwave oven used for laboratory research. They conducted a preliminary examination of the accident scene and, based on the arrangement of test equipment and signal leads, believed he was performing diagnostic work on the high-voltage power supply within the microwave. The power supply produced voltages of at least 600 volts. Medical evidence indicated that the electric current entered through the employee's right hand and exited through his shoulders.

Lessons Learned

The employee was working alone, contrary to the "two-person rule" that is Laboratory policy when employees work with energized equipment. This event emphasizes the importance of electrical safety training and adherence to procedures when working with electrical components.

ENGINEER SHOCKED BY CHARGED CAPACITOR

On March 26, 1997, at the Stanford Linear Accelerator Laboratory, an engineer received a shock when he contacted a charged capacitor while attaching a test probe in a high-voltage environment. Investigators determined that after the engineer turned off the voltage to the test cage, he neglected to actuate a shorting device used to discharge storage capacitors. Because he had also neglected to attach a test probe to the device, he rushed to attach one. Investigators determined the engineer did not use a grounding hook to ground the capacitors and was not wearing personal protective equipment. When the engineer jerked his hand from the cabinet, he received a slight cut.

At Sandia National Laboratory, a technician received an electrical shock when his right hand came close to a high-voltage bank of capacitors. The technician was working with another technician and a test engineer to repair a neutron controller for an explosive tester. They removed the cover from a pulse-forming network to determine if a relay was functioning. The network contained 14 capacitors connected in parallel that created a 4,200-volt potential. As the technician attempted to point to a low-voltage control board, he received the shock. He was not wearing the protective equipment for work on energized high-voltage systems required by procedures. The discharge path through his body was from the bottom of his right wrist to his elbow, which was in contact with the grounded metal chassis.

Lessons Learned

These incidents underscore the importance of following safety procedures when working on electrical equipment. High-voltage rubber gloves and safety glasses should be worn as a minimum. Workers need to be aware of stored electrical energy and the shock hazard of capacitive discharge. Workers can be shocked from charged capacitors even if the equipment has been turned off or disconnected from external power sources.

THREE DEATHS ATTRIBUTED TO LOCKOUT/TAGOUT FAILURE

Three equipment operators died September 8, 1992, in a California sawmill accident when the three entered a jammed “debarking” machine to adjust its operation and clear a log jam. The workers did not perform the lockout/tagout procedure that would have prevented the machine from starting while they were inside. During the investigation, other employees testified that although lockout/tagout procedures existed, they had not always been followed.

Lessons Learned

Lockout/tagout procedures must be used consistently to be effective. Doing it right every time is the only way to ensure safety. Inconsistent use of safety procedures can lead to bad habits and complacency. All workers should take the time to double-check that equipment has been properly locked and tagged out before working on it. It is never safe to assume that one of your co-workers will have taken care of it. Managers must communicate the rules of lockout/tagout as well as the risks of not following procedures.

It is important to remember that experience does not guarantee safety. Just because shortcuts have not resulted in an accident in the past does not guarantee that they won’t next time.